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SATELLITE OBSERVATIONS OF EXTREME ULTRAVIOLET RADIATION
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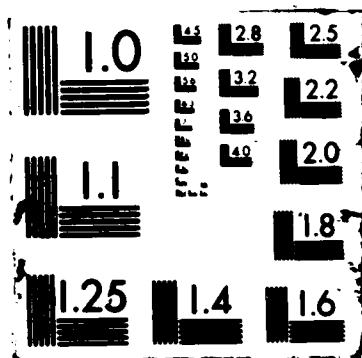
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) With the support of U.S. Army grant DAAG29-77-C-0031, the first Extreme UltraViolet (EUV) spectrometer (ECOM-721) was built and was flown on the DOD satellite P78-1. The instrument collected a large amount of high quality data on the Earth's atmosphere, ionosphere and magnetosphere. It is still the only such experiment performed from a satellite. Because the instrument was on a spinning satellite, in a noon-midnight polar orbit at 600km altitude, it obtained a huge amount of unique data of geophysical interest. A substantial number of important geophysical observations were made, including the first spectrum of the polar cusp under sunlight, the first spectrum of the EUV nightglow emissions, the first spectrum of the tropical airglow in the EUV, the first spectrum of the nightside aurora below 800A, the detection of dielectronic recombination emissions in the atmosphere, and the first spectrum of the polar cap emissions in the EUV.				
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FINAL REPORT

for

USARO DAAG29-77-C-0031

SATELLITE OBSERVATIONS OF EXTREME ULTRAVIOLET RADIATION

Stuart Bowyer

11 May 1987

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1. ECOM-721

With the support of U.S. Army grant DAAG29-77-C-0031, we built the first Extreme UltraViolet (EUV) spectrometer (ECOM-721) which was flown on the DOD satellite P78-1. This instrument collected a large amount of high quality data on the Earth's atmosphere, ionosphere and magnetosphere. It is still the only such experiment performed from a satellite. Because the instrument was on a spinning satellite, in a noon-midnight polar orbit at 600km altitude, it obtained a huge amount of unique data of geophysical interest. A substantial number of important geophysical observations were made, including the first spectrum of the polar cusp under sunlight, the first spectrum of the EUV nightglow emissions, the first spectrum of the tropical airglow in the EUV, the first spectrum of the nightside aurora below 800Å, the detection of dielectronic recombination emissions in the atmosphere, and the first spectrum of the polar cap emissions in the EUV. Some of these achievements are briefly discussed in the following:

- a) We have obtained the "average" dayglow spectrum in the 300 - 1400Å wavelength range by adding a large number of spectra within $\pm 40^\circ$ latitude range. The dayglow observation, obtained near local noon, is preceded only by two rocket measurements using scanning spectrometers having low sensitivity. Because our long integration time provides low statistical uncertainty, and the availability of information on temporal and spatial variations, the data set is ideally suited for studying the geophysical emission processes. The results of several dayglow studies have been reported in Chakrabarti et al., 1983, Kumar et al., 1983, Meier et al., 1983, McCoy et al., 1983 and Gladstone et al., 1984 and references therein.
- b) We have also obtained the first EUV nightglow spectrum and studied its morphology. The measurements were conducted near local midnight. For the first time the emissions from the night sky and their latitudinal variations are known to us, which is an important measurement for the astronomers, including the space telescope project. One of the important discovery of the nightglow measurements is the presence of OI 989Å feature in the tropical region. The emissions are produced by dielectronic recombination of O^+ ions (Abreu et al., 1984). This is the first observation of such phenomena in a planetary atmosphere. Other results pertaining the nightglow emissions are reported in Chakrabarti 1984a, Chakrabarti et al., 1984, and Yee et al., 1984.

- c) We have made the first set of measurements of different types of auroral forms in the EUV region. We have obtained the first spectrum of cleft aurorae under fully sunlit conditions near local noon (Paresce et al., 1983; Chakrabarti 1984a). We have also obtained the first EUV spectra of emissions inside the polar cap (Chakrabarti 1984c; Chakrabarti 1985). Of course, the spectroscopy and morphology of several night-side aurorae have been studied (Paresce et al., 1983a,b; Meng et al., 1985).
- d) We have now established the spectra of the dayglow, nightglow and several polar phenomena in the EUV. In order to verify the spectral identifications, one needs to perform detailed calculations and compare theoretical intensities to the observed ones. This is a non-trivial task. First, one has to invoke a neutral atmosphere model. MSIS is probably adequate for the low latitude regions. One needs a photoelectron production code to analyze the dayglow and the sunlit cleft emissions. Finally, one needs a radiative transfer code, because a large number of these emissions are optically thick. We have made initial attempts to perform such calculations. First, we have analyzed the OII 834Å data in the dayglow (Kumar et al., 1983; McCoy et al., 1983). We found that, assuming Chapman layer like O⁺ distribution, MSIS neutral atmosphere and a Complete Frequency redistribution radiative transfer model, we could explain the absolute intensities and the zenith angle profiles of the OII 834Å emissions. We have taken a small step towards analyzing the nightside auroral spectrum. We have assumed simple Maxwellian energy distribution for the primary electrons and MSIS model to theoretically predict the intensity ratios of several spectral features. Using these models we can obtain the altitude of the emission peak and the characteristic energy of the primary particles (Monchick et al., 1984). Although the models are rather crude, the exercise shows the potential of using the EUV measurements to remotely obtain important atmospheric and ionospheric parameters.

2. ECOM-501

A second instrument, ECOM-501, was developed under the auspices of this grant, and it is currently integrated in the DOD P80-1 spacecraft awaiting a launch opportunity. ECOM-501 is an imaging telescope which is optimized for the wavelength range 80-400 Å. It consists of a grazing incidence mirror with a geometric collecting area of 156 cm². The two bandpasses are selected by tin-film filters for the 60-340 Å range. The radiation is detected with an imaging microchannel plate detector which is read out in a 256×256

pixel format.

The instrument is mounted in the P80-1 spacecraft so that it will be continuously pointed toward the zenith in flight. The data set which is acquired during the course of the 1-year mission will consist of the brightness of the EUV background in the two bandpasses, with a spatial resolution of $\sim 0.1^\circ$. By observing over the course of a year, we will be able to characterize the geocoronal background as a function of solar angle and geomagnetic coordinates. We will also be able to determine the strength of the background emission which is produced in the solar system and beyond.

The instrument has been built, tested and calibrated and has been integrated into the P80-1 spacecraft. Since integration in August 1982, Berkeley has supported 13 spacecraft system-level tests which took place through November 1985. The spacecraft is currently in storage, where it will remain until launch preparations begin, approximately one year prior to launch.

LIST OF PUBLICATIONS CARRIED OUT UNDER THIS GRANT

1. "Continuous Readout EUV Airglow Spectrometer", S. Bowyer, R. Kimble, F. Paresce, M. Lampton, and G. Penegor, *Appl. Opt.*, 20, 477 (1981).
2. "Reliability Analysis of an Extreme Ultraviolet Spectrometer for Space Research," S. Chakrabarti, *Space Sciences Instrumentation*, 5, 137 (1980).
3. "Computer Aided Calibration of Extreme Ultraviolet Instruments," S. Chakrabarti, *Space Sciences Instrumentation*, 5, 151 (1980).
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9. "The OI 989 Å Tropical Nightglow," V.J. Abreu, A. Dalgarno, J.H. Yee, S. Chakrabarti and S.C. Solomon, *Geophysical Research Letters*, 11, 569 (1984).
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2. "The Berkeley Ultraviolet Spectrometer on STP78-1," S. Bowyer, R. Kimble, G. Penegor, M. Lampton and S. Chakrabarti, *EOS*, 60, 901 (1979).
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4. "The Earth's Extreme Ultraviolet Airglow," F. Paresce, S. Bowyer, R. Kimble, G. Penegor, S. Chakrabarti and M. Lampton, *EOS*, 61, 46 (1980).
5. "Spectroscopic Observations of the Tropical Ultraviolet Emissions," S. Chakrabarti, F. Paresce and S. Bowyer, *EOS*, 61, 1063 (1982).
6. "Preliminary Results from the Berkeley EUV Spectrometer on STP78-1 Satellite," S. Chakrabarti, invited seminar talk at the Naval Research Laboratory, Washington, D.C. (1982).
7. "Preliminary Results from the Berkeley EUV Spectrometer on STP78-1 Satellite," S. Chakrabarti, invited talk at the Goddard Space Flight Center, Maryland (1982).

8. "Preliminary Results from the Berkeley EUV Spectrometer on STP78-1 Satellite," S. Chakrabarti, invited talk at the Physics Department Colloquium at Utah State University, Logan, Utah (1982).
9. "Preliminary Results from the Berkeley EUV Spectrometer on STP78-1 Satellite," S. Chakrabarti, invited seminar talk at the Space Physics Research Laboratory Seminar at the University of Michigan (1982).
10. "Preliminary Results from the Berkeley EUV Spectrometer on STP78-1 Satellite," S. Chakrabarti, invited seminar talk at the Jadavpur University, Calcutta, India (1982).
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14. "Observations of an EUV (300-900 Å) Aurora from the STP78-1 Satellite," F. Paresce, S. Chakrabarti, R. Kimble and S. Bowyer, *EOS*, 64, 786 (1983).
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19. "Satellite Observations of EUV Atomic Oxygen Emissions in the Dayglow," R.R. Meier, S. Chakrabarti and M.D. Morrison, *EOS*, 64, 787 (1983).
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21. "Spectroscopy of Tropical Ultraviolet (800-1400 Å) Airglow from STP78-1 Satellite," R. Kimble, S. Chakrabarti and S. Bowyer, *EOS*, 64, 788 (1983).
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23. "Morphology of the OI 911 Å and 989 Å Emissions in the Tropical Nightglow," V.J. Abreu, S. Chakrabarti and S.C. Soloman, *EOS*, 64, 788 (1983).
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26. "Observation of an EUV (300-900 Å) Cleft Aurora under Full Sunlight," S. Chakrabarti, *EOS*, 65, 246 (1984).
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28. "Signatures of Polar Cap Emission Processes in the EUV," S. Chakrabarti, *EOS*, 65, 1020 (1984).
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30. "EUV Emissions for Monitoring Aurora," S. Bowyer, C.I. Meng and S. Chakrabarti, *EOS*, 65, 1020 (1984).
31. "Disparity between Model and Measurements of Atomic Oxygen OI EUV Emissions," R. G. Gladstone, R. Link, J. C. McConnell and S. Chakrabarti, *EOS*, 65, 1021 (1984).

32. "Theoretical Calculations of the 989 Å Tropical Nightglow," J. H. Yee, V. J. Abreu, G. R. Gladstone, R. G. Burnside and S. Chakrabarti, *EOS*, 65, 1021 (1984).
33. "Investigation of Vehicle Glow in the Far Ultraviolet", S. Chakrabarti and T. Sasseen, Presented at Workshop on Spacecraft Glow, NASA Marshall Space Flight Center, Huntsville, Alabama, May 6-7, 1985.
34. "A Parametric Study of Polar Cap Extreme Ultraviolet Emissions", S. Chakrabarti, G.R. Gladstone, R. Link and J.C. McConnell, *EOS*, 66, 319, (1985).

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